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2665, 2670 [Jan., Feb., Sept., and Dec., 1918]. **Proposed by CLIFFORD N. MILLS, Brookings, S. Dak.**

A telegraph wire which weighs 1/10 of a pound per yard is stretched between poles on a level ground so that the greatest dip of the wire is 3 feet. Find approximately the distance between the poles when the tension at the lowest point of the wire is 140 pounds.

III. Solution by J. B. Reynolds, Lehigh University.

Choosing any small portion of the wire of length as resolving tangentially and normally to the curve of equilibrium and passing to differentials we get the fundamental equations

$$T\frac{d\varphi}{ds} = w \cos \varphi, \qquad \frac{dT}{ds} = w \sin \varphi \tag{1}$$

in which T is the tension in the wire, w the weight per foot, φ the angle the tangent makes with the horizontal and s the length of the curve measured from the lowest point.

Dividing and integrating, we find

$$T = T_0 \sec \varphi \tag{2}$$

T_0 being tension at lowest point. Putting this value of T in the second equation above we find

$$ws = T_0 \tan \varphi. \tag{3}$$

Now since $\tan \psi = dy/dx$ and $ds/dx = \sqrt{1 + (dy/dx)^2}$ we may, from (3), arrive at the equation

$$y = \frac{T_0}{2w}\{e^{wx/T_0} + e^{-wx/T_0}\} - \frac{T_0}{w}, \tag{4}$$

y being measured vertically from the lowest point of the curve, which is taken as the origin. Likewise, from these equations we may find

$$T_0 = \frac{w}{8d}(l^2 - 4d^2), \tag{5}$$

where l is the length of wire between poles and d is the greatest dip, and

$$l = h\left\{1 + \frac{8}{3}\left(\frac{d}{h}\right)^2 - \frac{224}{45}\left(\frac{d}{h}\right)^4 \cdots\right\}, \tag{6}$$

in which h is the horizontal distance between poles. For this problem, $T_0 = 140$, $w = 1/30$; so, by (4),

$$y = 2100\{e^{x/4200} + e^{-x/4200}\} - 4200.$$

Expanding to x^2, we find, when $y = 3$, $x^2 = 25200$; whence $x = 159$ ft., $2x = 318$ ft., as a good approximation of the distance between poles.

If we use equation (5), we have $l^2 = 100836$; whence $l = 317$ ft.—a nearer value. Finally by using (6) we get $h = 316 +$ ft.

2679 [Feb., 1918]. **Proposed by J. W. LASLEY, JR., University of North Carolina.**

Show that the perpendicular from any point on a circle to any chord of the circle is a mean proportional to the perpendiculars from that point to the tangents at the ends of the chord.

Solution by C. E. Githens, Wheeling, W. Va.

Let CD be the perpendicular from the point C to any chord AB of the given circle, and let EC and CH be the perpendiculars from C to the tangents to the circle at the points A and B respectively. To prove $EC \times HC = CD^2$. The quadrilaterals $AECD$ and $BHCD$ are similar since the angles of the one are respectively equal to the angles of the other, that is, angle EAD = angle DBH, angle CDB = angle ADC = angle AEC = angle CHB, being right angles. Hence, the corresponding sides are proportional; that is, $EC : CD = CD : CH$, or $EC \times CH = CD^2$.

Also solved by C. A. Barnhart, Paul Capron, L. E. Mensenkamp, Roger A. Johnson, I. J. Fajans, Samuel Cohen, O. E. Simonsen, I. Millenky,